NASA TECHNICAL TRANSLATION NASA TT F-16051

AN INSTRUMENT PANEL ON A COLOR IMAGE TUBE

G. Raynaud

Translation of "Un tableau de bord sur un tube a image en couleur," Revue de Medecine Aeronautique et Spatiale, Vol. 11, 4th Quarter, 1972, pp. 217-219.

(NASA-TT-F-16051) AN INSTRUMENT PANEL ON A COLOR IMAGE TUBE (Kanner (Leo) Associates) 9 p HC $3.25 CSCL 01D

N75-12948

Unclas

G3/06 04975

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 DECEMBER 1974

STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TT F-16051		

4. Title and Subtitle	5. Report Date
AN INSTRUMENT PANEL ON A COLOR IMAGE TUBE	December 1974
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
G. Raynaud, Physician-in-Chief, First Class, Ophthalmologist, Armed Forces Hospitals	
	10. Work Unit No.
9. Performing Organization Name and Address	11. Contract or Grant No.
Leo Kanner Associates Redwood City, California 94063	NASw-2481
	13. Type of Report and Period Covered
	Translation
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code
National Aeronautics and Space Administration, Washington, D.C. 20546	

15. Supplementary Notes

Translation of "Un tableau de bord sur un tube a image en couleur," Revue de Medècine Aeronautique et Spatiale, Vol. 11, 4th Quarter, 1972, pp. 217-219.

16. Abstract

A new instrument panel component consisting of a cathode screen able to display the main flight parameters is described. The wavelengths of the three colors used and their brightness and contrast under varying intensities of ambient illumination are given. The compactness of the screen and the fact that the data are given in predigested form greatly simplifies the task of collecting information.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unclassified-Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	7	

AN INSTRUMENT PANEL ON A COLOR IMAGE TUBE

G. Raynaud

Physician-in-Chief, First Class, Ophthalmologist
Armed Forces Hospitals

A pilot in flight is a sort of airborne tabetic: he must use his eyes as "crutches" -- or at least the instrument panel must provide him with means of aeronautic cenesthesia and proprioceptivity. /217*

Moreover, there is no "cure," since at least 40% of the information obtained by homo erectus is visual.

In addition, this proportion must increase enormously for aviators, whose inner ear and proprioceptivity yield inaccurate information, disturbed by the maneuvers of the aircraft. An aviator must use his eyes even to control his breathing.

Aircraft designers, therefore, have attempted to furnish lighter and more efficient "crutches" to simplify the steering system and the instrument panel.

With this in mind, we will proceed to a discussion of the Electronic Attitude Director Indicator (EADI) developed by Thomson-CSF.

Description

This system consists of an instrument panel component made up of a cathode screen capable of displaying the main flight parameters: heading, elevation, pitch, altitude, speed, flight director, ILS speed vector, potential gradient, alterable perspective diagram of landing strip, etc. Suitable choice of these characteristics depending on the flight phase should permit all-weather steering in Category III B, including taxiing on a landing strip in fog.

---

*Numbers in the margin indicate pagination in the foreign text.

This screen is part of an integrated monitoring and control system whose other components will not be described here. We will mention only the visible interface, designed to increase the simplicity and compactness of a conventional instrument panel, and the angles of vision necessary for its use.

This is a cathode tube with an image in which the dot (rather than modulating by sweeping across a fixed grid, as in television) moves in such a way as to give a direct description of the scales, indices and symbols to be displayed, operating in the same way as the tip of a luminous scriber.

Thus the characteristics of the image are quite specific and offer marked advantages over television from the standpoint of contrast and (especially) clarity.

A) The screen is a 7" rectangular screen measuring 130 mm long by 130 mm wide, with a diagonal of approximately 165 mm.

Designed to be viewed at a distance of between 70 and 80 cm from the eye, at this distance it falls within a solid angle of a little more than 10°.

This screen produces a fluorescent display of lines denoting scales, indices, symbols and alphanumeric characters.

B) The theoretical width of this line is slightly in excess of 0.4 mm; this remains constant no matter what the direction or curvature of the line may be. To produce these lines the dot moves at a speed of 1 mm per microsecond for any shape or orientation of the line.

-- The image is renewed 60 times per second, which is greater than the critical frequency of fusion. The threshold of the critical frequency of fusion is known to increase as one approaches the central fixation zone.

The afterglow time of phosphorus compounds ranges from approximately 2 to 10 msec depending on the compound involved, and the trail effect during the transverse movement of a line cannot be detected visually.

C) Three colors are used:

-- a red with a dominant wavelength of 615 nm;

-- a green with a dominant wavelength of 555 nm;

-- a yellow-white,obtained by mixing these two colors, whose /218
exact wavelength could not be determined.

D) The maximum luminances of these two wavelengths are:

-- red: 80 and 100 nt;

-- green and yellow-white: 450 to 500 nt;

with values as high as 2500 nt in the case of local voltage increases.

The relative lack of precision in these measurements is a result of the fact that heterochromous photometry is involved, and that in addition the large surface range of the photometry must be compared with a much finer line whose structure is much less uniform.

E) In darkness, the background of the screen will have a slight luminance when the tube is on; this will range from 0.010 nt to 2 nt, depending on the brightness of the fluorescence of the symbols and their proximity. Thus the contrast under these optimum conditions is excellent.

F) However, the luminance of the background of the screen depends primarily on the ambient illumination, which has no effect on the brightness of the lines. (This problem has already occurred in connection with airborne radar.)

Our measurements were performed on a prototype which has since been improved by the addition of filters and antireflecting coatings, with the result that our values are not as good as those currently being given by the designer.

Under perpendicular exposure to the rays of the midday sun, with a clear sky and an interposed layer of glass, a sheet of white paper took on a luminance of 15,000 nt, while the screen assumed 2,750 nt. The red and white lines were completely effaced, while the green lines were still visible.

In very light shadow, quite close to the range of exposure to the sun, the luminance of the sheet of paper was 1500 nt and that of the screen 600 nt. Under these conditions the green and yellow-white could easily be read from 2 m, while the red required somewhat closer attention.

Given the brightnesses obtained, one would expect poorer visual results. The advantage gained may be due to the fact that the contrast between colors is added to that of the luminosity.

Under weaker illumination the visibility of the lines and their contrast no longer presented any major problems since their luminance could be adjusted for maximum comfort and efficiency.

For example, the illumination from a 75-watt lamp at a distance of 1 m yielded a luminance of 10 nt from the sheet of paper and 4 nt from the screen.

Comments

Of the ergonomic problems presented to the observer, the sharpness and readibility of the line are obviously of prime importance.

1. The luminous structure of the line is quite different from that of a printed line, for example: the latter is a rectangular luminance scale (aside from ink smudges), while in the case considered here, the luminance of the line follows a gaussian distribution and has no electronic limit. This limit is set at 0.4 mm for the brightnesses included in the standard deviation of the gaussian curve. Visually, this statistical blurring of edges can scarcely be detected; the line may appear 0.5 to 0.7 mm thicker.

Its angular opening is 2-3', which is much higher than the threshold of visibility. One should take into account that this is a luminous display on a dark background and that visibility will be somewhat facilitated as a result.

The resolving power of the screen is 0.4 mm; thus this is also above the acuity threshold. Movements and overlapping equal to 1/3 the thickness of the line can in fact be distinguished with the naked eye.

The size of the alphanumeric symbols is 4 mm, that is, about 20 minutes of an angle. The thickness of the line making up these symbols is always the same, making them sharper than equivalent 14-point type (P 14 for ophthalmologists), whose visibility threshold for the normal eye is 3.50 m.

The readability of the EADI is slightly higher than this value on an initial estimate, but this remains to be confirmed.

Tests are under way on the basic problems of readability, as well as related problems involving the shape of the symbols and their arrangement in a limited space. Reports on these problems will be forthcoming.

2. The second problem involves variations in contrast in a brightly illuminated environment:

-- light from the sun striking the screen directly will result in zero readability;

-- bright diurnal illumination will hinder readability somewhat; as a result, if other means of increasing the contrast on the screen are not found, it would be necessary to maintain a reasonable and fairly unvarying level of illumination in the cockpit to preclude the necessity for frequent adjustment of the contrast. Obviously, this would be in conformity with the attitude of aircraft designers who would prefer to eliminate the windshield, after decreasing its size considerably. The manufacturer states that this head-down display is designed precisely for this purpose: its precision and reliability will make any recourse to direct vision completely unnecessary, even during landing. When one has seen the runway, in available head-up systems, appear in the exact location where its alterable perspective diagram is being projected on the windshield, this argument tends to be highly convincing. Let us therefore leave the final solution to this problem to further research and the choice of the users, involving as it does the additional problems of claustrophobia and avoidance of collisions.

3. The third problem is that of the compactness of the screen and the number of parameters it should be able to display.

It should first be noted that this system allows the presentation of only those data necessary for the flight phase in progress, and that these data are usually "predigested," electronically prepared to facilitate their assimilation by the pilot. As we have seen, in this system some new parameters have been chosen to replace less useful information.

The result is a considerable simplification of the visual work of grasping information.

An examination of the IFR standard table and the screen involved demonstrates these possibilities for simplification [photograph not included].

Thus there are fewer data presented and these data are in /219
simpler form, but there is also a decrease in display area.

We have compared the size of this display area with that of a Vautour panel. This panel, which is 41 cm wide and 22 cm high, has a surface area of 902 cm^2, compared with the 130 cm^2 of the EADI. When one takes an angle of 10^o the Vautour panel requires a 30^o opening.

There are no appreciable differences in these proportions in more modern aircraft (Boeing 747).

Here two possible results may be seen:

a) First, continuous and systematic scanning of the panel, "fishing for information," undoubtedly will not be performed in the same way. Assuming that the same amount of time is required to read each of the data, the "blind time" during which the eye travels from one instrument to the next should be shortened considerably.

b) However, it is not certain that the scanning procedure here will be analogous to the familiar procedure of scanning individual separated screens. This is because the EADI is projected onto the retina completely within the central zone of maximum definition. In an area with a 5° radius around the macula, the acuity is greater than or equal to 3-4/10 (Adler, Ludwig). It is still 2/10 within a circle with a radius of 10°, that is, to the right side of the image on the screen, when the eye is fixed to the left. The approximately 4 mm size of the alphanumeric characters necessitates acuity of only about 2 to 3/10. It is therefore possible that parafoveal vision, whose importance in simplifying visual scanning is well known (in reading, for example), will play an important part in the task of collecting information here and will partially supplant or simplify the movements of the eye, and by the same token will increase the visual and overall efficiency of the pilot.

As an ophthalmologist, I have not turned to the problem of zero-visibility flight out of perversity; not only does vision still have an important place in this type of flight, but these new and, in a sense, revolutionary devices create visual situations which, although simplified, are still so new and artificial that they may raise more questions than we will be able to answer.